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5642

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(Charlotte, NC, 2-4 June 2003) (Deadline: 25 May 2003)

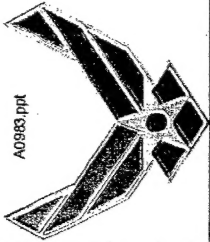
(Statement A)

Multi-Scale Strain Measurements of a Polymeric Material



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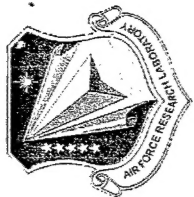


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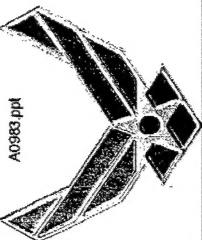
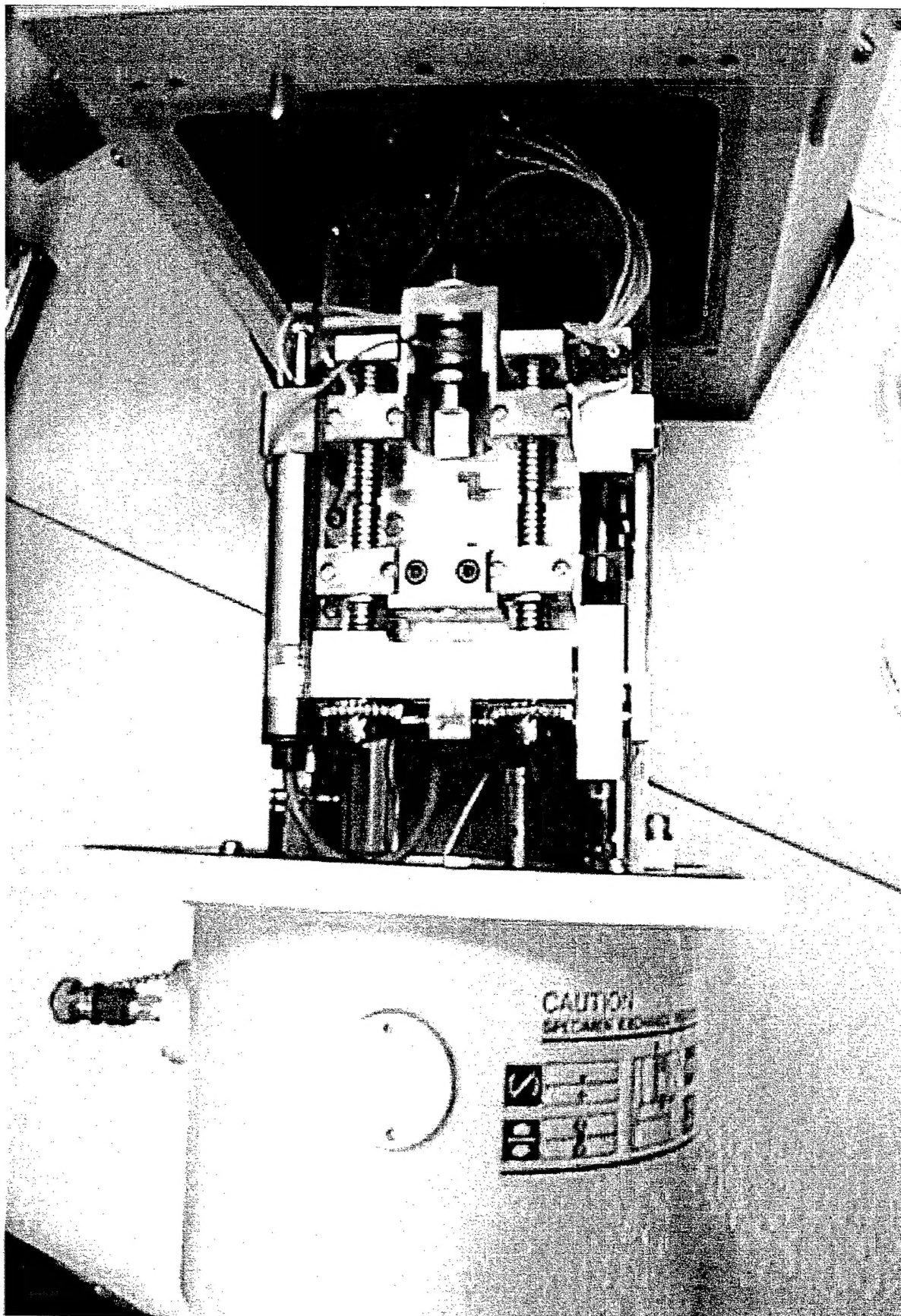
Objectives

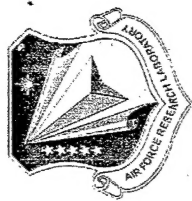
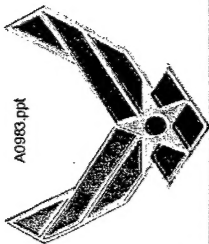


- Determine the Displacement and Strain Fields in a Polymeric Material
- Investigate the Local Damage Mechanisms and Failure Behavior near the Crack Tip

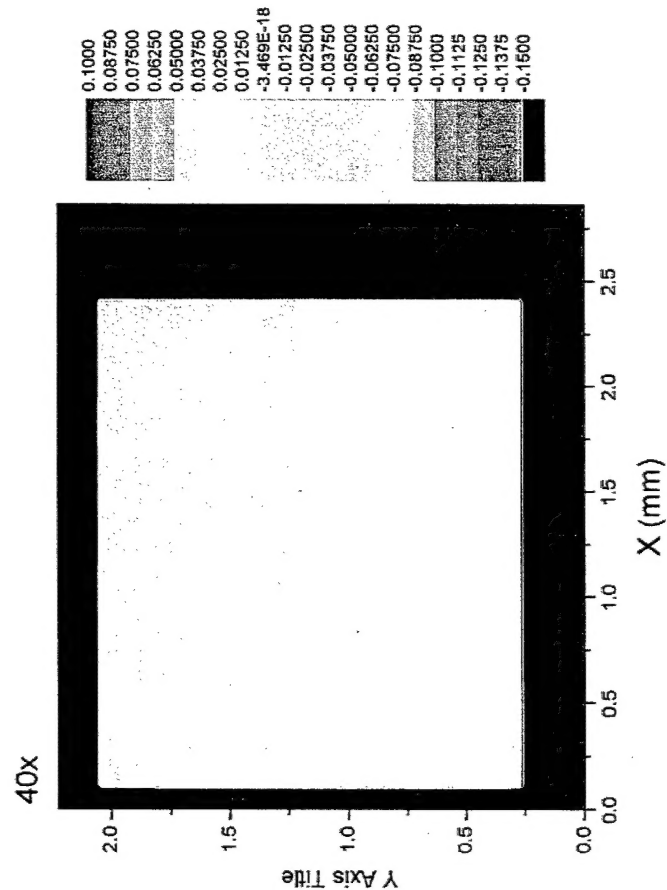


Testing Set-Up

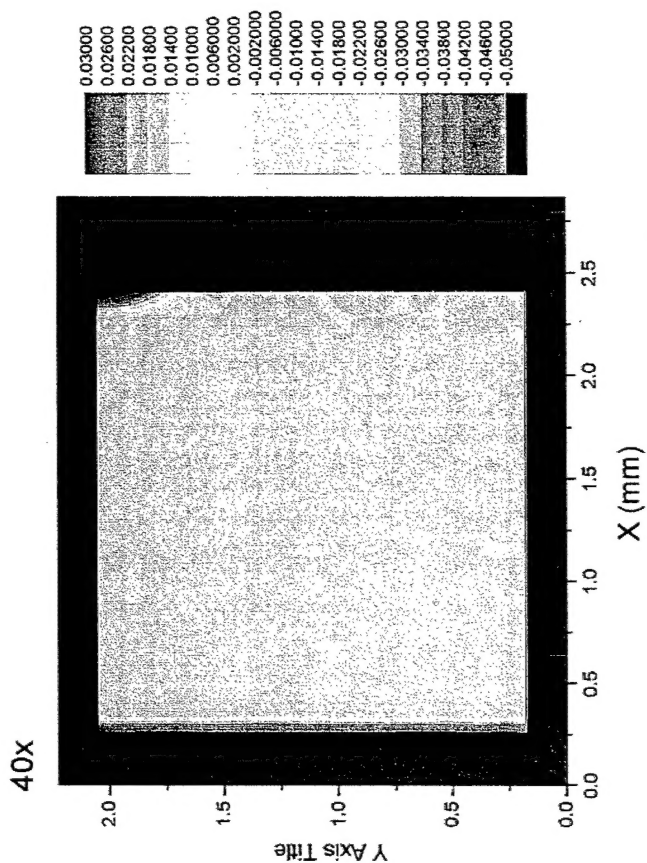




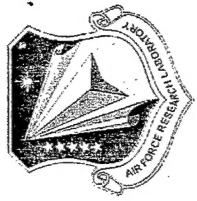
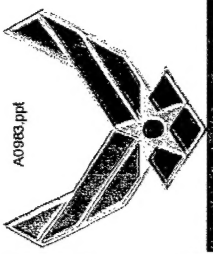
Strain Distributions (2.5mm x 2.0mm)



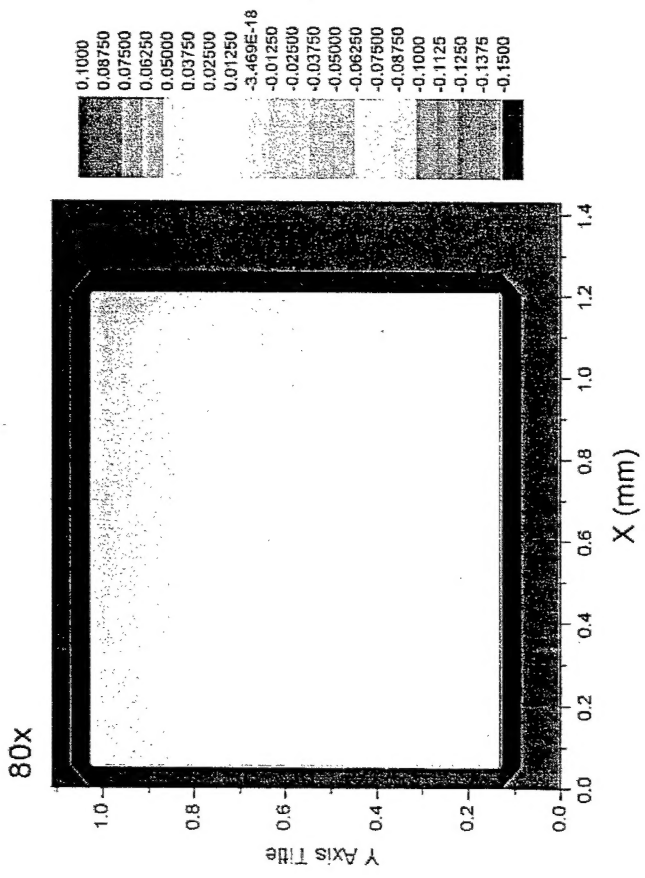
ϵ_{yy} field, Load = 52 grams



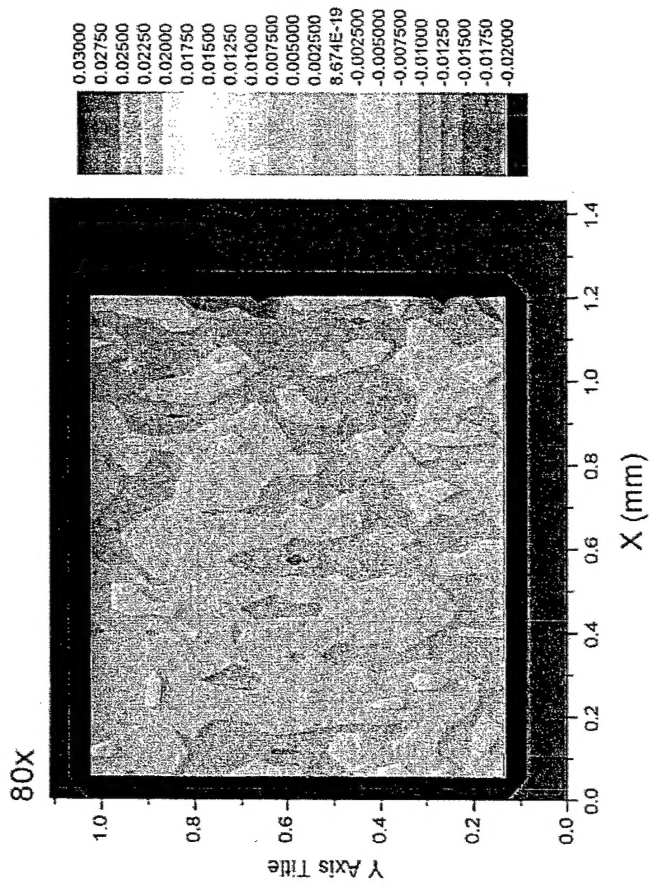
ϵ_{xx} field, Load = 52 grams



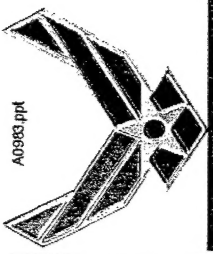
Strain Distributions (1.2mm x 1.0mm)



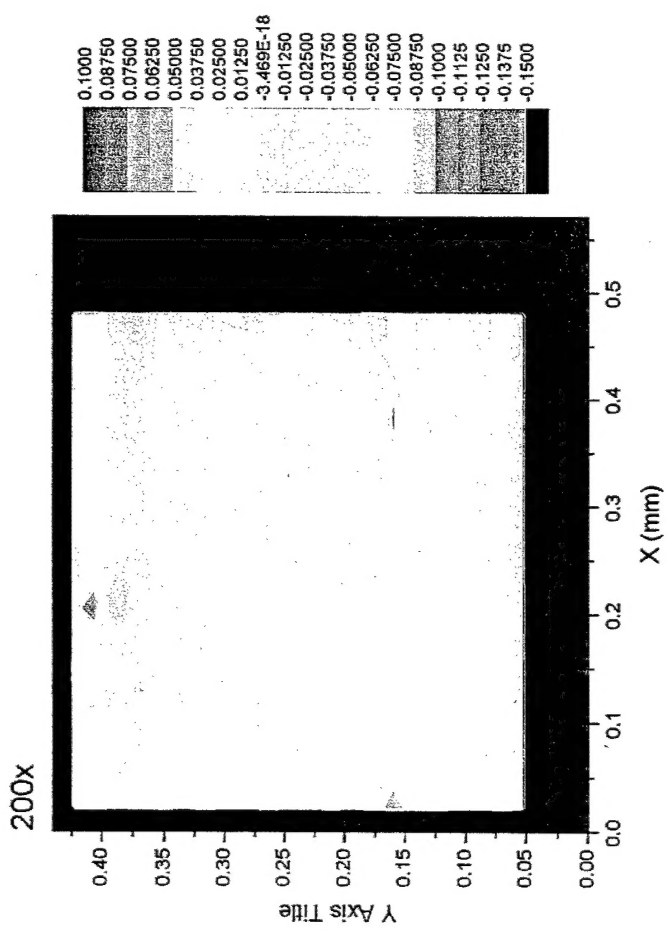
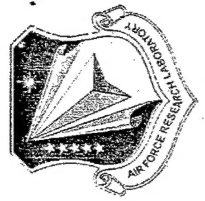
ϵ_{yy} field, Load = 41 grams



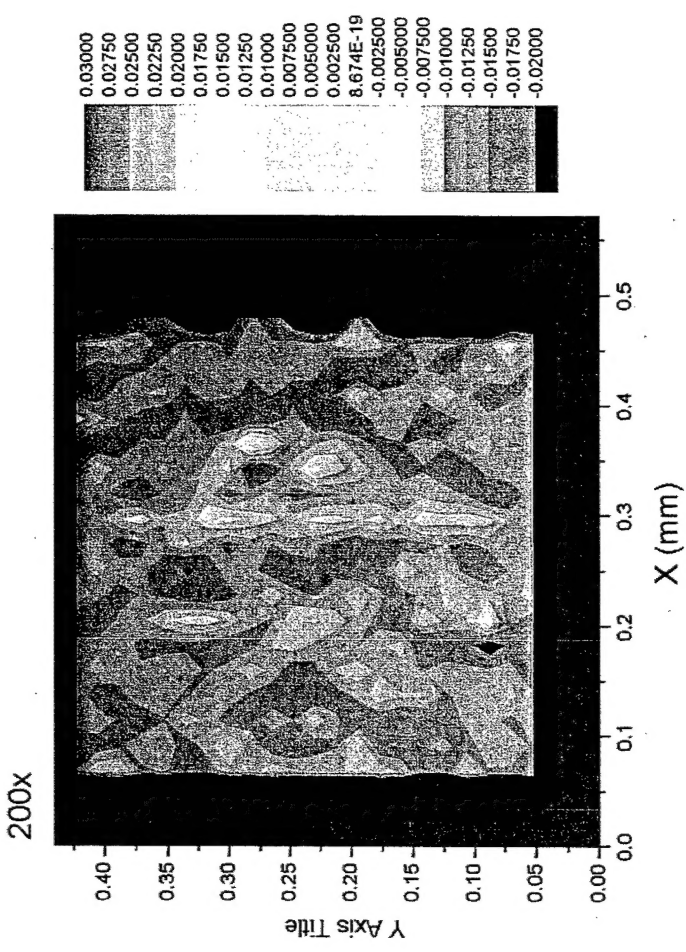
ϵ_{xx} field, Load = 41 grams



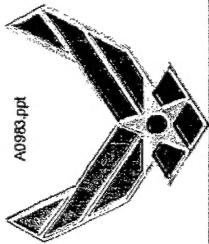
Strain Distributions (0.5mm x 0.45mm)



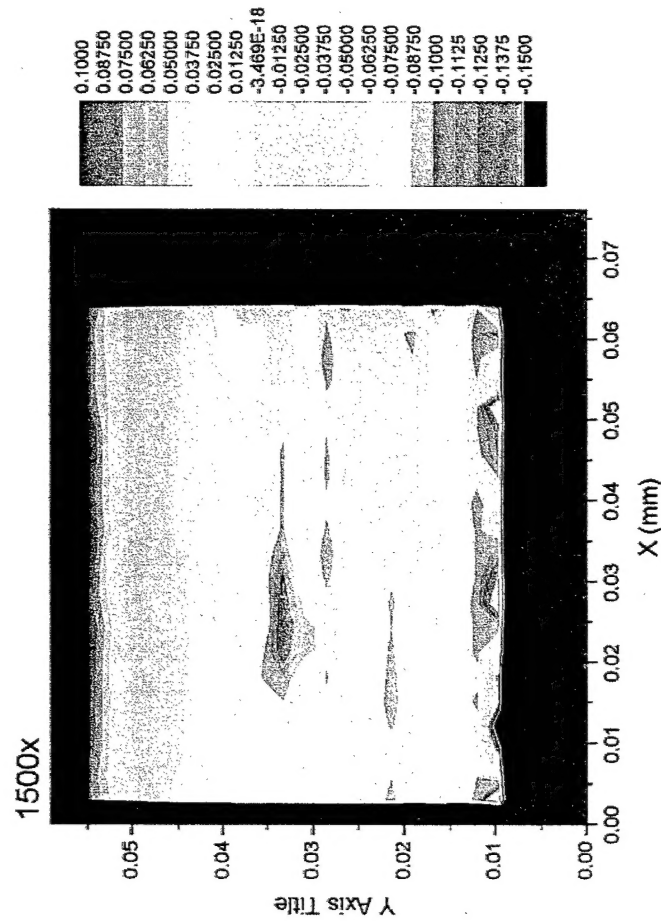
ϵ_{yy} field, Load = 47 grams



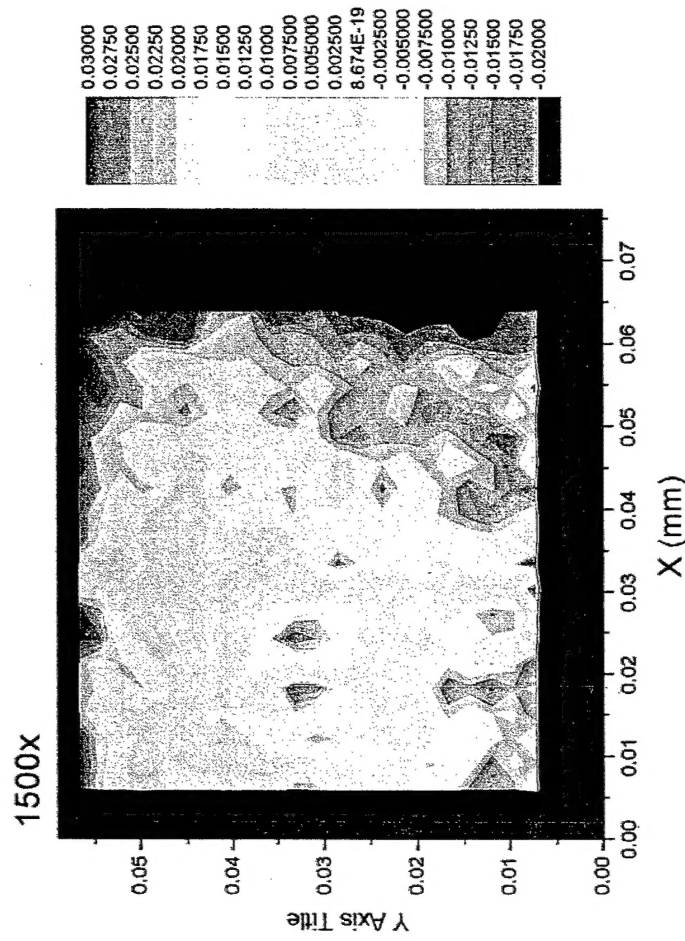
ϵ_{xx} field, Load = 47 grams



Strain Distributions (0.065mm x 0.055mm)

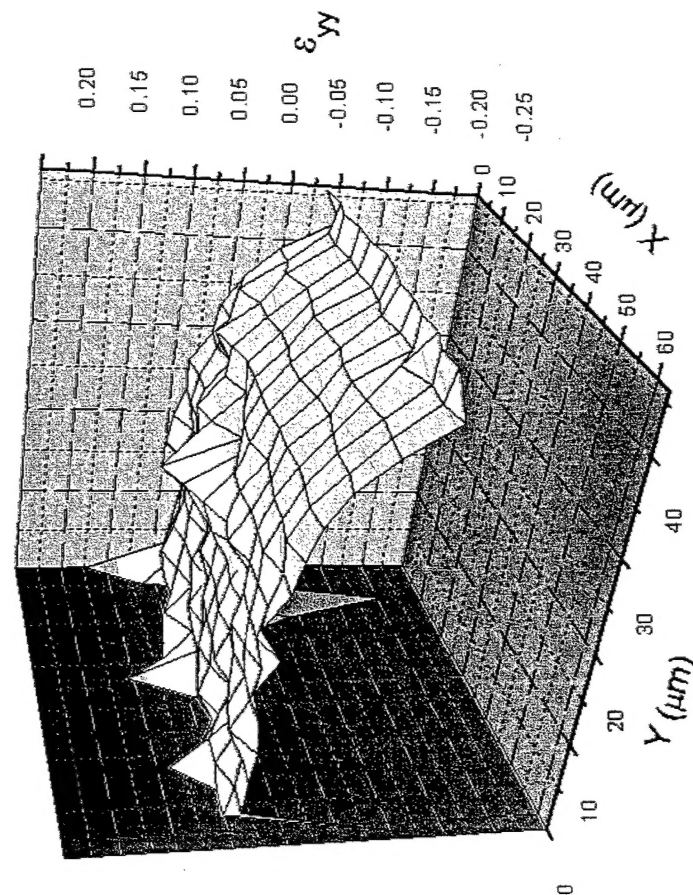
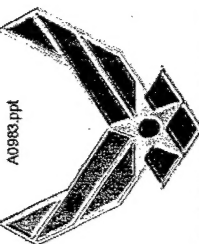
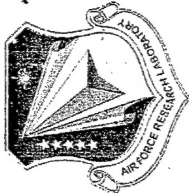


ϵ_{yy} field, Load = 49 grams

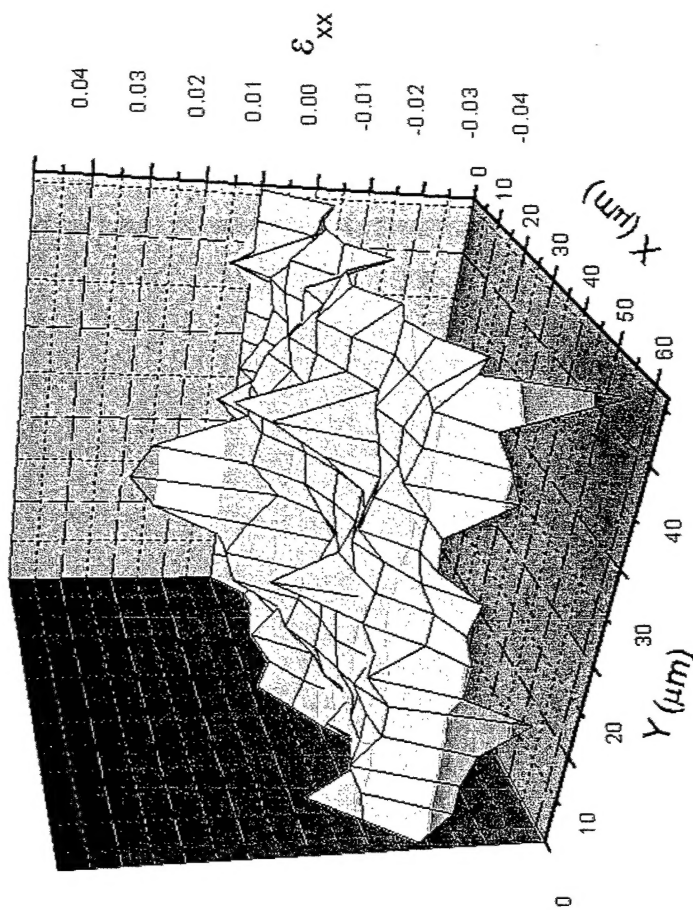


ϵ_{xx} field, Load = 49 grams

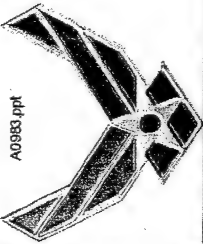
Strain Distribution (0.065mm x 0.055mm)



ϵ_{yy} field (3-D), Load = 49 grams



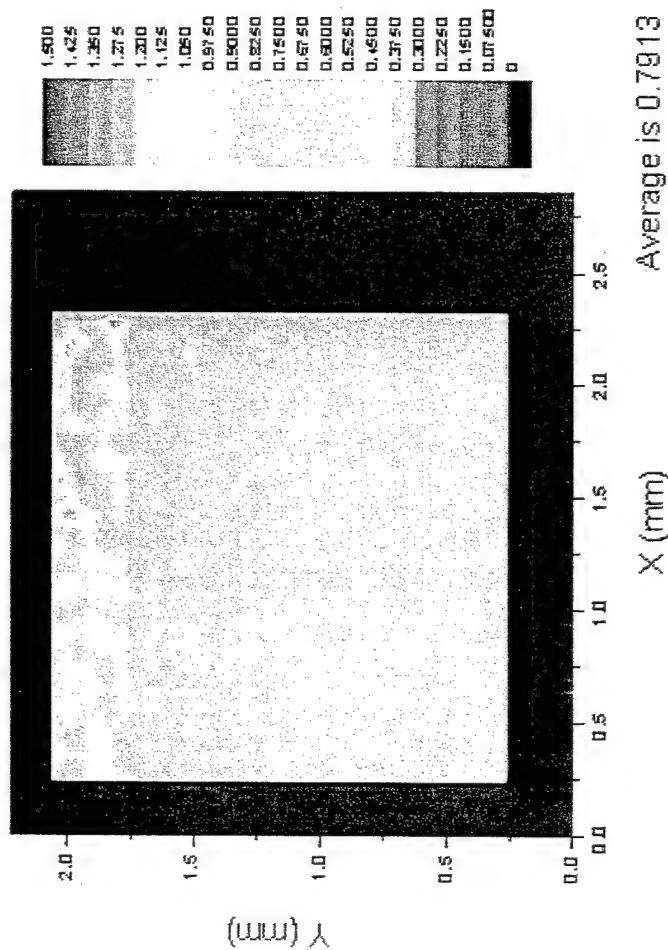
ϵ_{xx} field (3-D), Load = 49 grams



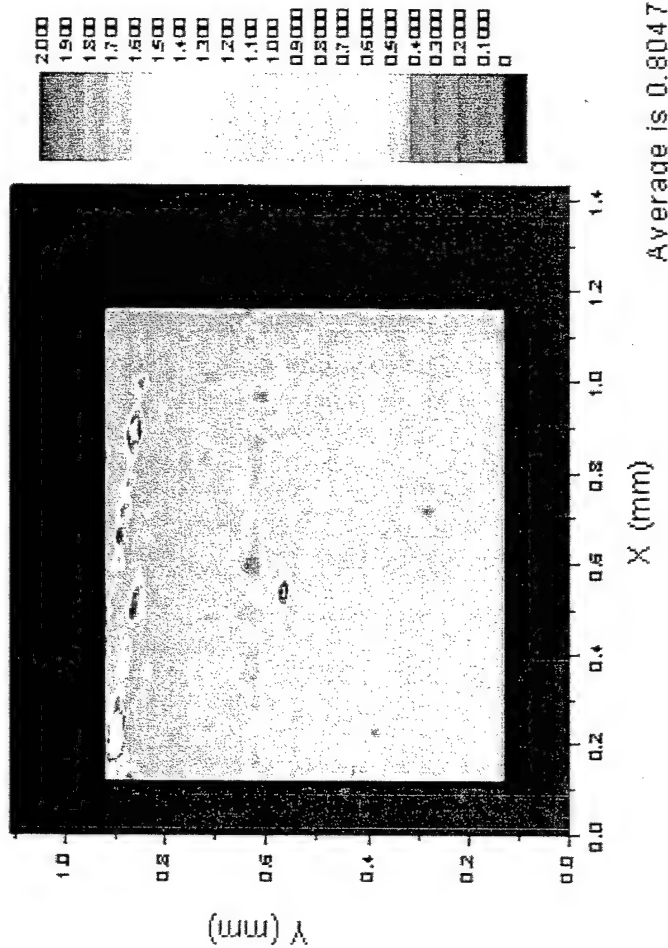
Strain Ratio ($-\varepsilon_{xx}/\varepsilon_{yy}$) Distributions at Different Magnifications

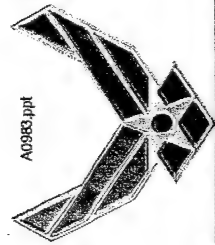


40x "Poisson Ratio" distribution



80x

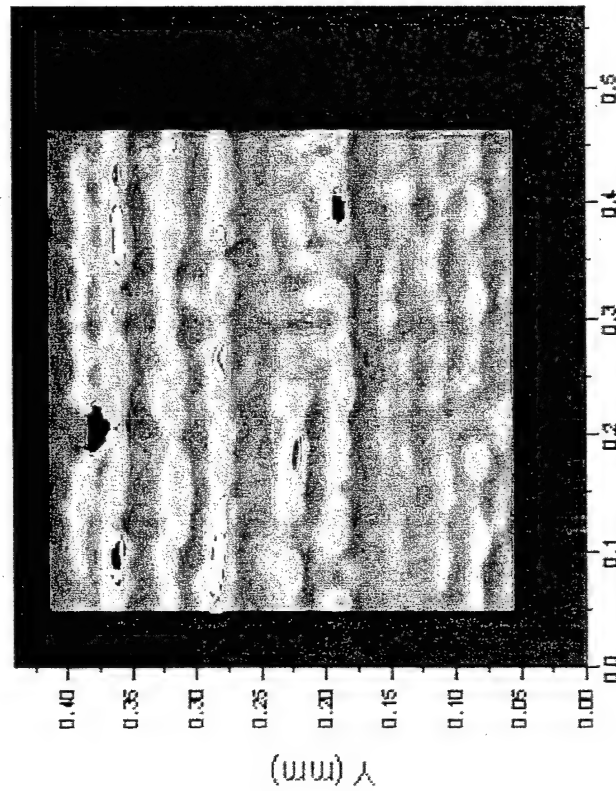




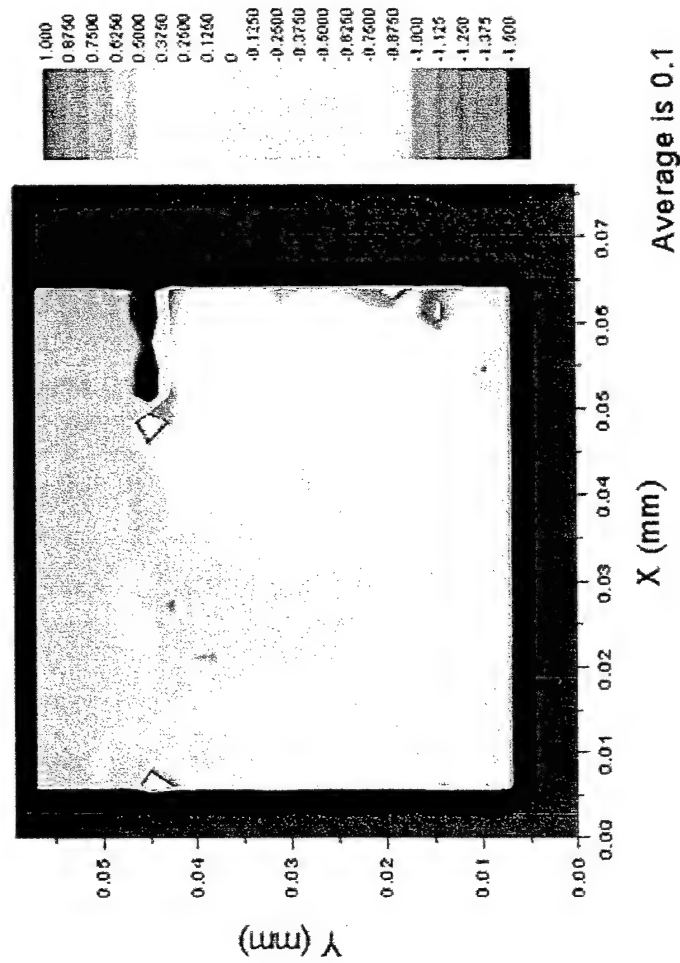
Strain Ratio ($-\varepsilon_{xx}/\varepsilon_{yy}$) Distributions at Different Magnifications

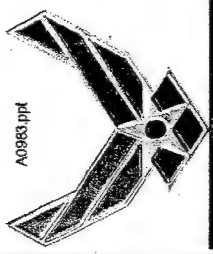


200X



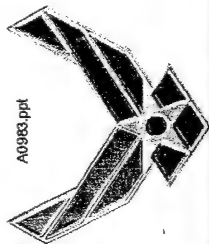
1500X



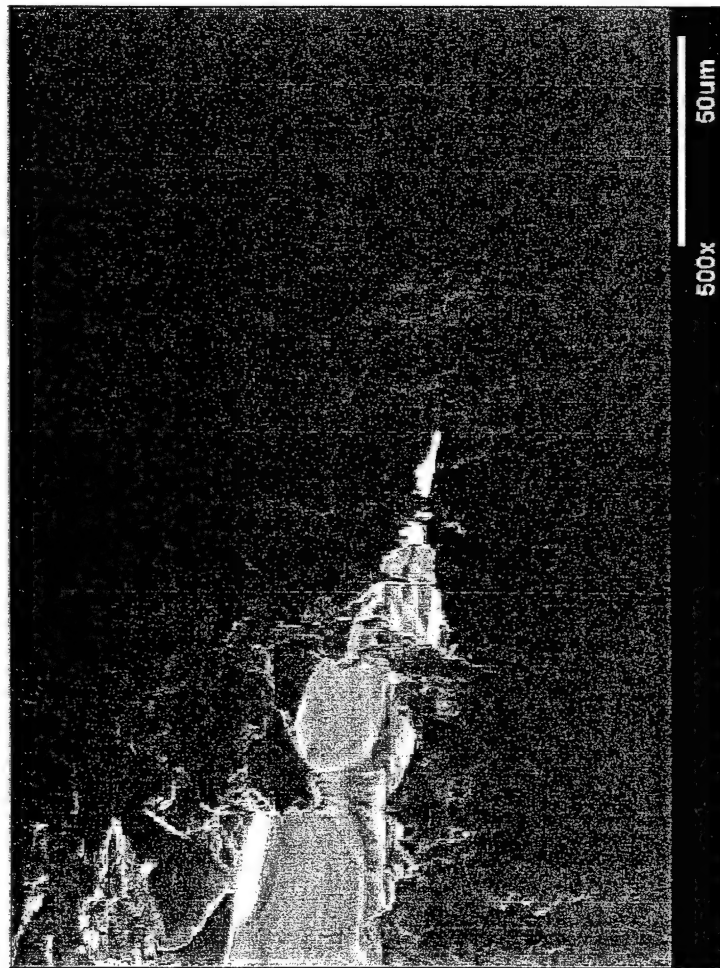


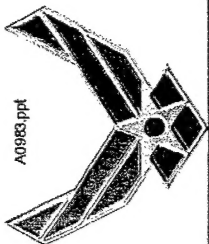
Side View of Crack Tip at 150x & 400x



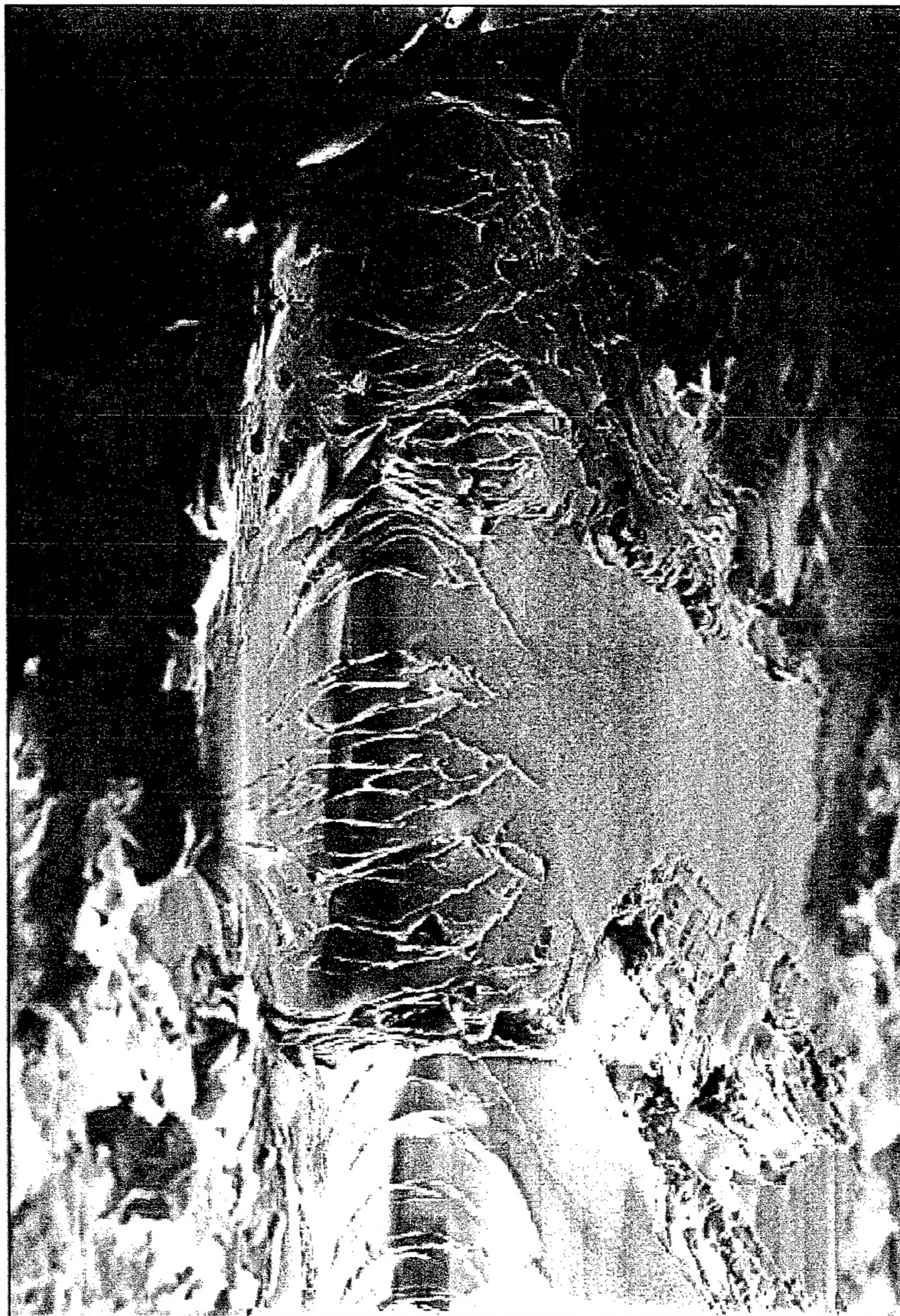


Side View of Crack Tip at 500x & 1000x





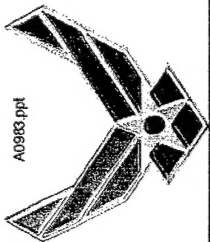
Crack Tip Top View



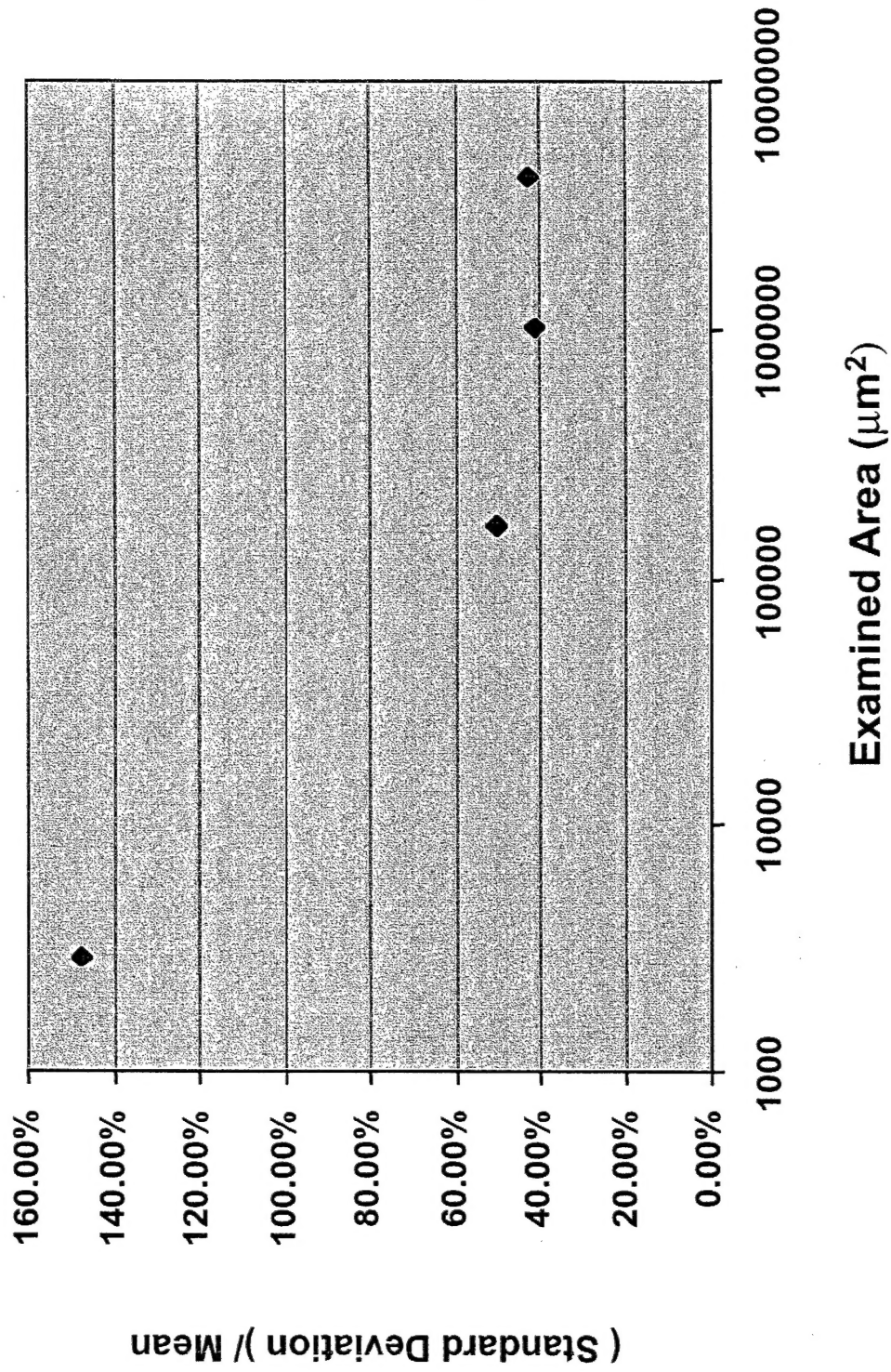
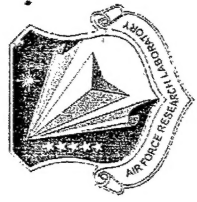
07/12/2002

150x

200um

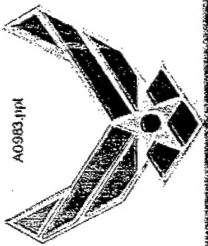


Standard Deviation / Mean of ϵ_{xx} Vs. Examined Area

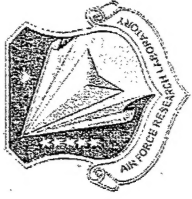


This graph shows the Coefficient of Variation (std dev/mean) on the y-axis (ranging from 0 to 0.005) versus Stretch in inches on the x-axis (ranging from 0.00 to 0.35). The data is plotted for 1000 cycles. The y-axis is labeled 'Coefficient of Variation, std dev/mean' and the x-axis is labeled 'Stretch, inch'. The graph features a grid with major lines every 0.0005 on the y-axis and every 0.05 on the x-axis. A horizontal dashed line is drawn at approximately 0.0042. A solid line with diamond markers represents the mean, which remains relatively constant around 0.0042. A dotted line with triangle markers represents the standard deviation, which shows more variation, peaking around 0.0045 at a stretch of 0.15 inches and dipping to about 0.0038 at a stretch of 0.10 inches. Other data series include a line with square markers and a line with cross markers, both of which are very close to the mean line.

Stretch, inch	Mean (diamonds)	Std Dev (triangles)	Squares	Crosses
0.00	0.0042	0.0042	0.0042	0.0042
0.05	0.0042	0.0042	0.0042	0.0042
0.10	0.0042	0.0038	0.0042	0.0042
0.15	0.0042	0.0045	0.0042	0.0042
0.20	0.0042	0.0042	0.0042	0.0042
0.25	0.0042	0.0042	0.0042	0.0042
0.30	0.0042	0.0042	0.0042	0.0042



Conclusions



- The strain distributions vary with the size of the area, A, in which the data were analyzed.
- When the size of A is smaller or equal to 1.5 mm x 1.5 mm, the nonuniformity of the strain distributions is increased. Especially, when the size of A is equal to 0.065 mm x 0.055 mm, both tensile and compressive strain fields exist in the small area
- The representative area, which is defined as an area in which the material's microstructure has no significant effect on the strain distribution, of the material considered is 1.5 mm x 1.5 mm.
- A highly damaged region of 20-50 micron long is developed at the crack tip.
- The crack growth mechanism involves voids formation ahead of the crack tip and the coalescence of the main crack tip with the void.